

Southwest Fisheries Science Center
Administrative Report H-94-08

THE HAWAIIAN MONK SEAL ON MIDWAY ATOLL, 1994

L. L. Eberhardt

K. V. Eberhardt

2528 W. Klamath Ave.
Kennewick, Washington 99336

September 1994

NOT FOR PUBLICATION

This Administrative Report is issued as an informal document to ensure prompt dissemination of preliminary results, interim reports, and special studies. We recommend that it not be abstracted or cited.

ABSTRACT

Status of the Hawaiian monk seal, *Monachus schauinslandi*, was studied at Midway Atoll in the Northwestern Hawaiian Islands from 5 March to 31 March 1994. Beach counts were made on both Sand Island and Eastern Island. The average beach count on Sand Island was 4.3 seals (19 counts, range 1 to 8 seals), and the average on Eastern was 6.4 seals (9 counts, range 1 to 10 seals). There were also 2 adult females with nursing pups on the small island between the two major islands (Spit Island) present during much of the visit, so the overall average beach count for Midway Atoll was 12.7 seals, excluding the two newborn pups. All but one of the untagged seals were bleach-marked as they were located. Using these marks in conjunction with tags present on many seals resulted in identification of 29 seals. Probability calculations suggested that we found all, or nearly all, seals using the site during March 1994.

INTRODUCTION

Mean beach counts over the last 4 decades have indicated that the monk seal population was virtually extirpated on Midway Atoll by about 1970 (Kenyon, 1972). Numerous beach counts were made in 1956 and 1957, averaging about 50 seals (Rice, 1960). Because reproduction was severely reduced during the long military occupation of the atoll, it appears quite certain that there may have been a much larger population present before the military activities began, suggesting the potential for a sizable future population. The naval facility at Midway was "decommissioned" in 1992 and cleanup activities are scheduled to be completed by 1997, after which human occupation of the atoll may be reduced to a few U. S. Fish and Wildlife Service (FWS) personnel. It thus was desirable to make a detailed assessment of the number of seals present. The major purpose of this study was to try to identify the population composition for further analyses of the future prospects of the Midway population.

METHODS

Daily beach counts were conducted during 5-31 March, 1994, and video camera work was used to document the apparent condition of individual seals, along with scar markings and other pertinent information. Difficulties in accessing Eastern Island made it impossible to make 2-day atoll-wide counts, so counts were limited to Sand Island for the first 12 days. When it became possible to reach Eastern Island, we concentrated on that site. Access to Spit Island was even more difficult so that only three visits there were possible. With the exception of one subadult female on Spit, all seals were identified either by tag number or by bleach-marking at the first encounter. Individual seals were assigned a temporary identification number as they were encountered. With the one exception, every sighting resulted in a positive identification.

RESULTS AND DISCUSSION

Twenty-nine individual seals were identified on the basis of scars, temporary bleach marks, and tags (Appendix A). Notes on individual seals appear in Appendix B. No sick or debilitated seals were seen. One adult female had what appeared to be "mobbing" injuries on her back but was healing well and appeared to be in good condition.

Sighting Matrices and Probability Calculations

For convenience in further analysis, sightings are recorded in a separate matrix for Sand and Eastern Islands (Table 1), with sightings designated by a 1, absence by zero. Sighting probabilities were calculated as the number of sightings divided

by the total number of cells in the matrix. Identification number entries in boldface in the matrix indicate that the given seal was first seen on the other island; i.e., No. 16 was first seen on Eastern Island, while Nos. 1 to 12 in the Eastern Island matrix were first seen on Sand Island.

The average probability of sighting for Sand Island was $(81)/(15 \times 19) = 0.284$, while that for Eastern Island was higher, being $(58)/(9 \times 17) = 0.379$. A probability of sighting any given seal can be calculated by first considering the probability that a given seal is not detected in n censuses and subtracting that probability from unity, i.e., $\Pr\{\text{sighting seal}\} = 1 - (1-p)^n$, where n = number of census counts. The large number of counts made on Sand Island make it appear unlikely that a seal using that site would escape detection, and we thus focus on Eastern Island, where fewer counts were possible. The relevant calculation for Eastern Island is $P = 1 - 0.621^9 = 0.986$, suggesting that a seal using the island would be unlikely to escape detection.

A problem, however, is that this calculation rests on the assumption of a common, constant probability of detection for all seals. This is unlikely to be a valid assumption, inasmuch as several of the seals seen at Eastern Island had apparently spent a fair proportion of their time on Sand Island, while others may use Eastern almost exclusively. Also, sightings very likely are "autocorrelated"; i.e., seals may tend to stay on the beach for several days and then leave for several days in a row. If there were a constant probability, equal for all seals, it would result in a binomial distribution of frequency of sighting, giving the pattern of expected and observed frequencies for Eastern Island (the calculations are necessarily adjusted for seals not seen at all, with probability $(1-P)^n$) (Table 2). Apparently there were too many seals seen only once, and the data may suffer from what is commonly called "capture heterogeneity" in the terminology used in capture-recapture studies.

A relatively new statistical technique, called "bootstrapping" (Efron and Tibshirani, 1993) provides a way to investigate the likely impact of capture heterogeneity here. Many (5,000 in this case) independent random samples of the same size as observed (here, $n = 17$, the number of individual seals seen) are drawn from the observed sample, with replacement (i.e., the same individuals can be drawn more than once in a single bootstrap sample) and used to repeat the relevant calculation. We thus draw 5,000 samples of 17 seals from the matrix of observations for Eastern Island, calculate a sighting probability from each sample and convert that to the probability used previously, $\Pr\{\text{sighting seal}\} = 1 - (1-p)^n$. The advantage of the technique is that it tends to reflect the actual underlying distribution of the data, rather than assuming that a theoretical distribution (here, the binomial) holds for the data. A

frequency distribution of the results of bootstrapping the Eastern Island data is shown in Figure 1.

This thus gives us an approximate notion of the impact of the capture heterogeneity; i.e., it suggests that heterogeneity will not have a major impact on the outcome, inasmuch as most of the outcomes are above 0.95, indicating that there is a high probability that all of the seals using Eastern Island were located.

The fact that we were only able to go ashore on Spit Island on 3 occasions complicates matters somewhat. On the first occasion (3/17) there was an adult female (with a gray tag) with a large pup there, and one small dark individual in the water near shore. On the next visit (3/26) the adult female and pup were gone, but there were two new females with pups, 2 tagged seals and a J2 (a large juvenile) female that we did not manage to mark. On the third visit (3/27) both the females with pups were present, along with a small dark individual (probably the one seen on 3/17), that we bleach-marked (and subsequently observed on Eastern Island). The females with pups appeared to have preempted the beach facing Sand Island, and no other seals were observed there. The other seals seen on Spit were on a beach facing Eastern Island that we were able to observe from Eastern (the other beaches on Spit were steep, and unlikely to be used). The general impression was that Spit was used occasionally, but was often not occupied by seals other than those with pups.

The overall conclusion from our observations is that it seems likely that the 29 seals observed may have been virtually the entire "population" using Midway Atoll at the time of our visit, but that there may well have been one or two other seals around. It is, of course, evident that some seals may move between Midway and the neighboring sites (Kure Atoll and Pearl and Hermes Reef) and, thus, may not have been present during our visit. Tag records (Appendix A) give further information on the origins of seals seen there, and their fidelity to the site. Appendix B gives a listing of the 29 seals seen by the temporary identification number, along with other observations made on these individuals. Appendix C lists the sectors where seals were seen on each island; sector information is available from the Protected Species Investigation, National Marine Fisheries Service, 2570 Dole Street, Honolulu, HI 96822-2396. This research was conducted under the following permits issued to the Southwest Fisheries Science Center: National Marine Fisheries Service Marine Mammal Permit No. 898, and U. S. Fish and Wildlife Service Special Use Permit MID-02-94.

REFERENCES

- Efron, B., and R. J. Tibishirani.
1993. An introduction to the bootstrap. Chapman and Hall,
New York.
- Kenyon, K. W.
1972. Man versus the monk seal. J. Mammal. 53:606-615.
- Rice, D. W.
1964. Population dynamics of the Hawaiian monk seal. J.
Mammal. 41(3):376-385.

Table 1--Sightings of Hawaiian monk seals on Eastern and Sand Islands.

Sand Island																				
Date (March)																				
ID	5	6	7	8	9	10	11	12	13	14	15	16	18	21	22	23	24	25	31	TOT
1	1	1	0	1	0	1	1	0	1	0	1	1	1	1	0	1	0	0	0	11
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	6
4	0	1	0	0	0	1	0	0	1	1	1	0	0	1	1	1	0	1	1	10
5	0	0	1	0	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	6
6	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
7	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3
8	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3
9	0	0	0	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	11
10	0	0	0	0	0	0	1	1	0	1	0	0	1	0	1	0	0	1	1	7
11	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	1	1	7
12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
13	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	1	1	0	1	7
14	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	3
TOT	2	3	4	3	1	4	3	2	7	7	8	2	6	4	6	6	4	4	5	81

Easter Island										
Date (March)										
	17	19	20	23	26	27	28	29	30	TOT
1	0	0	0	0	0	0	0	0	1	1
2	0	0	0	0	1	0	0	0	0	1
5	0	0	0	0	0	1	1	0	0	2
6	0	0	0	1	0	1	0	1	0	3
7	0	0	0	1	0	1	1	1	1	5
10	0	1	0	0	0	0	0	0	0	1
12	1	0	0	0	1	0	0	0	1	3
15	1	1	0	0	0	1	1	1	1	6
16	1	1	0	0	1	0	0	0	0	3
17	1	0	0	1	1	1	0	1	0	5
18	1	1	1	1	1	1	1	1	1	9
19	0	1	0	1	1	1	0	0	0	4
20	0	0	0	0	1	1	0	0	1	3
21	0	0	0	0	1	1	1	1	1	5
25	0	0	0	0	0	0	1	1	1	3
26	0	0	0	0	0	0	1	1	1	3
29	0	0	0	0	0	0	0	0	1	1
TOT	5	5	1	5	8	9	7	8	10	58

Table 2--Sightings of Hawaiian monk seals on Eastern Island.

Number of sightings	Expected	Observed
1	1.30	4
2	3.17	1
3	4.52	6
4	4.14	1
5	2.53	3
6	1.03	1
7	0.27	0
8	0.04	0
9	0.00	1
Total	17.00	17

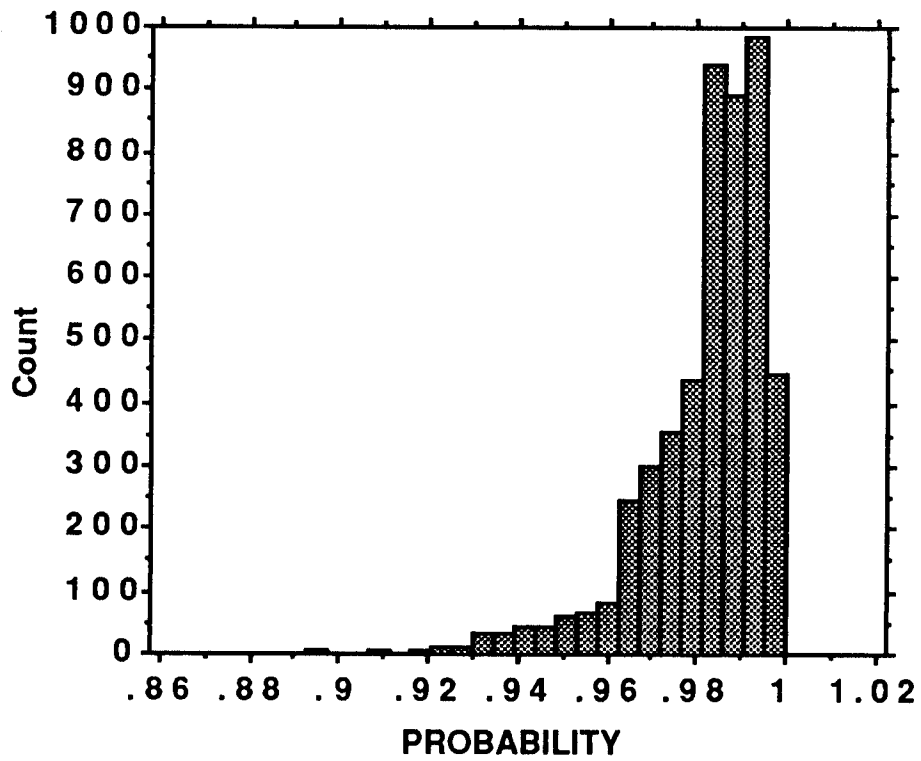


Figure 1--Frequency distribution of the results of bootstrapping Eastern Island data.

Appendix A--Identification numbers of seals seen at Midway Atoll, 1990-1994, years seen, sex (female = F, male = M, U = unknown), and age (in 1994). Ages shown in parentheses are estimated; adult = A, weaned pup = W, pup = P). Temporary ID's shown are those assigned during the present study.

Perm. ID	Sex	Age	Temp. ID	90	91	92	93	94
B1AM	F	(5)	19					1
BA01	M	11			1			
BF26	F	6	15					1
BF40	F	6					1	
BK01	M	9			1			
BK03	M	9	7	1	1	1	1	1
BK21	M	9				1	1	
BK27	F	9	2	1	1	1	1	1
BK33	F	9	23		1	1	1	1
BN44	M	7	29			1		1
BN58	F	7				1	1	
BN64	F	7					1	
BU16	F	5				1		
KF72	F	6				1		
KN88	F	7	25	1	1	1		1
K056	F	9	6	1	1	1		1
KZ62	F	3			1			
KZ96	F	3	20			1	1	1
R1AA	M	(6)	13		1	1	1	1
R1AC	M	(5)	9			1	1	1
RF06	F	6		1	1	1		
RS00	F	2	4			1	1	1
RX00	F	1				1		
RZ00	M	3	17		1	1	1	1
RZ02	F	3	10		1	1	1	1
YG21	F	4			1	1	1	
YG37	F	4	11			1		1
YS12	F	2	18					1
YS47	F	2	12					1
YU03	F	5		1				
YZ03	F	3	3			1	1	1
	F	A	1					1
	F	A	5					1
	F	(5)	8					1
	F	A	14					1
	F	A	16					1
	U	W	21					1
	F	(3)	22					1
	F	A	24					1
	M	W	26					1
	U	P	27					1
	U	P	28					1

Appendix B--List of seals identified on Midway Atoll in March, 1994. The first number given is a temporary identification, assigned as seals were located. All tags seen are listed, along with the permanent identification number (in parentheses). For tag numbers, penultimate characters indicate left (L), or right (R) rear flipper; ultimate characters indicate tag color: red (R), yellow (Y), blue (B), or Kure gray (K).

Seals sighted first on Sand Island

1. Adult female identified by scar pattern ("T-scar"). Bleached with E. This seal was the most frequently seen, turning up at Eastern only on the last visit there. Injuries appear to be healing well; good video of scars on first and last (as well as other) sightings. Seal has apparent mobbing injuries consisting of large oval on back, below which there is an inverted "T." She also has 3 small circular scars ventrally on line between flippers.
2. K26LB (BK27). Seen once on Sand and once on Eastern; did not get a chance to see right flipper so not known if second tag is in place yet. This female has been seen here every year from 1990.
3. Z07RR; Z183RY; Z06LR; Z182LY (YZ03). All 4 tags seen. Tagged on Midway in 1992.
4. S01RR S00LR (RS00). Bleached with A. Seen for last 3 years.
5. Adult female. Hook-shaped scar right ventral incised; good identification; good videos of scar. Seen mostly on Sand but also twice on Eastern. Bleached with B; has old wound in lower mid-ventral about where penis hole should be and initially thought to be male.
6. 612RK; T12RK (K056). Could not see left (apparently Temple tag added later as 606 and 612 shown on printed list.) Bleached with C. Seen on both Sand and Eastern.
7. K02LB (BK03). Only part of right tag present (post and fragment). This seal has two crescent shaped scars as cross on right dorsal; scar card made; good videos of scar. Seen with Temp. No. 8 on 3 occasions (3/7 and 3/13 on short beach by pier and then on 3/15 in sector 4), then seen alone on Eastern on 3/23. Seen on Eastern on 3/27 with Temp. No. 6 lying close together. Then seen on Eastern on 3/28 with No. 25. Observed swimming along beach and hauled out to approach No. 25; video coverage of subsequent interaction. Seen again on 3/29 on Eastern with Temp No. 25; observed us approaching to look at tag on No. 25 and charged; very

protective. Seen on Eastern on 3/30 with No. 25; lying close together. She spotted us and started to move to water, but male prevented her leaving beach.

8. Female Subadult 4 (large subadult) Bleached with "D" but bleach didn't take; faint but definite blotch on back (evident on videos). Seen with #7 4 times; close together, and then not identified again.
9. 1ADLR; 1ACRR (R1AC). Seen >4 times; tags reversed in master id. Listed as subadult male in 1992, so presumably approaching adult status, but not seen in close association with females.
10. Z02LR; Z03RR (RZ02).
11. G37LY; G137RY; G30RK (YG37). Released at Kure in 1991.
12. S47LY; S28LK (YS47). Released at Kure in 1993; seen here in January according to John Henderson, who listed tags as S47LY, S28LK, S147RY, S29RK. All 4 tags present. Two-year-old female.
13. 1ABRR; 1AALR; (R1AA). Male first recorded as S3 (small subadult) in 1991, and thus presumably adult, but not seen in attendance of female on any occasion (seen 6 times).
14. Adult female. Bleached; attempted "F," but bleach mixed poorly; distinct mark in midline of back but irregular like Xmas tree; seen again; bleach distinct, but not likely to be recognized as an "F"; have videos of bleach.

Seals first seen on Eastern Island and Sand Spit

15. F26LB; F28RB (BF26). Apparently not seen here previously. Six-year-old female.
16. Adult female bleached with "H". Seen again; good bleach. Sleeping soundly when bleached and later on Eastern; then seen 3 times on Sand but very nervous there.
17. Z00RR; Z01LR (RZ00).
18. S70RK; S71LK; S12LY; S112RY (YS12). Apparently not seen here before; released at Kure in 1993. S112RY seen on 3/26 (all tags confirmed).
19. 1AMLB; 1ANRB (B1AM). Apparently not seen here before (not on list of tags). Apparently tagged on Pearl and Hermes in 1991. About 5 years old.
20. Z78LK; Z09RR; Z79RK (KZ96).

21. Black pup; apparent weanling; "blimp" appearance; no female in sight and two females with NEW pups seen on spit on same day. Seen on approximately the same spot 5 days in a row on Eastern.
22. Untagged J3 (small juvenile) female (?) on Spit; lying on back; not seen again; not able to attempt bleaching; possible that this was No. 8, but had impression that this seal smaller than No. 8.
23. K32RB (BK33). Female with new pup on Spit (born since 3/17 visit; same location as female seen with gray tag and large pup). TAG WORN; OTHER FLIPPER NOT VISIBLE (didn't want to risk startling female). Could only get ashore on Spit 3 times; however, checked from boat on 3/30 and both females and pups (this one and No. 24) were visible.
24. Female with new pup. Female has distinct (large) bleach 42 (bleached at Kure Atoll in previous month) and not there on previous visit to Spit (3/17).
25. Assigned to female with gray tag seen with pup on 3/17. Female N89RK (KN88) seen with male on 3/28, 3/29, and 3/30 and assumed to be this individual. However, could be different seal. Have videos of seal with pup and of KN88.
26. Black J1 (small juvenile) marked with bleach "J" on Spit on 3/27; seen next 3 days on Eastern at same location. In water on 3/28 persistently trying to catch something under concrete block; have videos of this. Sleeping soundly on next two visits. Very fat; guess him to be yearling, but probably pup born early in the season.
27. Pup with No. 23; number assigned for convenience in tallying total different seals seen.
28. Pup with No. 24.
29. N30LB (BN44). First sighted on 3/30; lying with No. 15. This is the only other adult male we saw with a female. R1AA (No. 13) was recorded on Midway in 1991 as S3 (small subadult), and thus is presumably "adult"; however, we did not see him in close association with a female (but was within 50 feet or so of 9 and 12 on 3/14).

Appendix C--continued.

Eastern Island		Sand Island	
Sector	Frequency	Sector	Frequency
2	7	3	4
3	8	4	2
4	7	6	8
5	5	7	5
6	9	8	1
7	12	9	2
8	4	10	5
9	4	11	13
Total	56	12	12
		13	11
		15	4
		16	9
		19	1
		28	4
		Total	81

